Water Statistics in Brazil: an Overview

By Judicael Clevelario Junior,
Valdir Neves,
Paula Terezina Tudesco Macedo de Oliveira Valéria Grace Costa
Pedro Amendola
Roberval M. Rocha
Júlio Jorge Gonçalves da Costa
IBGE.

Abstract

Brazil is a large country with different hydro conditions. The majority of the country has a humid climate, with plenty of water availability. But an area of about 900.000 km^2 has a semi arid climate, with severe water scarcity, and a larger area suffers with seasonal water scarcity (3 to 5 months per year). Due to the federative structure of Brazil, the water statistics are collected by the federal, state and municipal institutions. Usually the federal ones collect information about volume and sediments transported by the larger rivers, and compile and disseminate information about human supply and waste water (sewage) treatment in national scale. The state institutions are concerned with surface water quality, beach water quality (environmental agencies), human supply and sewage treatment (public and private water companies). Some municipalities monitor the water quality in beaches and control the human supply and sewage treatment. There is some overlapping of actions among federative agents and important gaps and/or omissions in some water statistics (underground water, irrigation). Other problems faced by Brazilian water statistics are the differences in sampling and analytical methodologies used, spreading of data, and gaps in time series. Another important question is how to choose the data to be presented as representative of Brazilian conditions, how to summarize Brazilian varied realities. ANA (National Water Agency) and IBGE (Brazilian Institute of Geography and Statistics) are trying to organize, independently and for slightly different purposes, the Brazilian water statistics.

Introduction

Brazil is a large country with abundant water resources. However, these water resources are not homogeneously distributed by the Brazilian territory. The north of Brazil (i.e., the Amazon region) concentrates the majority of the water resources, although it is the least populated area in Brazil. On the other hand, the inland areas of North-East region, with a semi arid climate, have scarcity of water resources and a large population (it is considered the most densely populated semi arid area in the world). In other areas, especially in the South and Southeast regions (which are also densely populated), the water scarcity is due to the super exploitation and misuse (mostly because of heavy pollution) of surface water resources. In the Central Region of Brazil, there is some water scarcity during the dry

season (3 to 5 months per year), especially for agricultural purposes, due to the type of climate, which has strongly marked seasonal differences in rainfall.

Additionally to this, Brazil has a federative political-administrative structure, with responsibilities for the monitoring and management of water resources shared among the Union (the Federal government), the States and the Municipalities. These shared responsibilities are reflected in the collection and processing of information and statistics concerning water, produced by all the federative stances. Due to a certain inaccuracy in the definition of respective responsibilities, some water statistics are collected and processed by more than one of the federative entities. Sometimes, for the same kind of information, different methodologies of sampling and analyses (physical and chemical) are used.

IBGE (Instituto Brasileiro de Geografia e Estatística - Brazilian Institute of Geography and Statistics), that can be described as a federal agency of economic, social, demographic, geographic and environmental information (properly produced or compiled) about Brazil, is initiating a process of collection, compiling, organizing and dissemination of statistics about water in Brazil. IBGE produces only a small part of these statistics, but has a tradition of critical analysis, compiling and releasing of information. A data bank with information about water statistics (who produces and what is produced) is being prepared, but is still in a quite preliminary stage.

The aim of this article is to present the way Brazilian water statistics are organized, the institutions responsible for them and how IBGE can participate in the structuring and organization of Brazilian water statistics. This paper is organized in statistics about surface waters (essentially river waters), underground waters, water use (human supply) and waste water treatment, irrigation and quality of coastal sea waters (bathing water quality).

Surface Waters - River Statistics

The statistics concerning rivers (volume of water and sediments and water quality) are produced by federal and state institutions. The federal institutions collect information on the largest Brazilian rivers about the volume (flow) of water and sediments, and their variation during the year. These date have been collected over a long time and were (and are) used to project dams for various purposes (hydropower generation, irrigation, human supply, flood control, etc.), and other river constructions.

In the last years, the states initiated the collection of data about water volume and sediment transport by rivers. Also, the states make physical and chemical analyses of water quality. These analyses encompasses turbidity, pH, concentration of N (nitrate, nitrite and others N compounds), P (phosphates), Cl (chlorine), organic pollutants (pesticides and others), heavy metals, chemical and biochemical oxygen demand (COD and BOD) and other analyses. For some rivers, these analyses are also made for the sediments. Not all analyses are made in all rivers. The purpose of the states physical and chemical analyses and statistics are the evaluation of water quality and environmental pollution, and to project dams and others constructions in rivers. Also, the states, in conjunction with some municipalities, are

responsible for the distribution of water for human direct consumption and for the treatment of waste water (sewage).

The states environmental agencies are responsible for the monitoring and analyzing of water quality. Some states (Minas Gerais) have specific institutions for water monitoring and management (IGAM – Minas Gerais State Water Institute).

Some states are more advanced than others in monitoring river conditions. This is due to the demographic, social and economic reality of the states, which varies largely in Brazil. This is reflected in the coverage, frequency of data collection and types of analyses made. In some states, all the river basins are monitored. In others no basins are monitored at all. In this case we have the majority of Northern states, which encompasses the Amazon basin. For those states we have only the federal data (volume of water and sediments), more dispersed in spatial terms, and scarce information collected by universities and others research institutes.

In terms of water chemical characteristics, IBGE develops a project to classify the surface waters in the North-East of Brazil, the region with a predominance of a semi arid climate. The aim of this project is to map the surface and underground waters in terms of salt type and concentration. This mapping can help the regional and local authorities, and others decision makers, in the most appropriate uses of water in the region with the highest scarcity in Brazil. In the future, this mapping can be expanded to all Brazil.

Nowadays, ANA (National Water Agency) is the federal institute responsible for the collection and analyzing of river water data. In the past, others institutions (DNOCS – National Institute of Drought Combat, DNAE – National Institute of Water and Waste Water Management, Eletrobras – Brazilian Electric Company, ANEEL – Electric Energy National Agency), some of them already extinct (DNOCS, DNAE), were responsible for this.

ANA is now organizing hydrographic basin committees to monitor the water quality and to control water distribution and use in the river basins. This project is in its first stages (few basins are organized in committees) but the purpose is to discipline the use of waters and to guarantee their quality.

The National Council of Environment (CONAMA – Conselho Nacional de Meio Ambiente) establishes the standards of water quality, determining the limits of the parameters used to classify water quality in classes of potential uses.

Subsurface and Underground Waters

In Brazil, underground waters are used in rural areas for human supply and irrigation in a moderate scale. In a large scale, underground waters are beginning to be used in areas where the surface water sources are scarce (such as in the North East), where they are heavily used or where their use is problematic due to heavy water pollution (Central and Southern Brazil).

Brazilian South, South-East and Central Regions share with neighboring countries - Paraguay, Argentina and Uruguay - the confined aquifer considered the largest in the world: the Aquifer Guarani. In some areas, especially in the South-East Brazil, the water of Guarani aquifer is used for human supply, industrial and agricultural (irrigation) purposes. The South-East is the most populated and economically developed region of Brazil and, due to that, the waters of Guarani Aquifer are in danger of being contaminated by pesticides and fertilizers (used in agriculture), sewage, industrial residues and toxic products buried in the soil. Efforts are being made by Brazil and its neighbors to delimitate, quantify and control the use of Guarani aquifer waters.

The Brazilian geological survey institute (CPRM - Companhia de Pesquisa de Recursos Minerais) surveys the volume, flow and chemical composition of Brazilian underground waters, but much work must be developed in this field to provide a better idea of the Brazilian reservoir of underground waters.

IBGE, as cited above, is analyzing the chemical quality (salt type and concentration) of the underground waters in the semi arid region of Brazil (North-East Region).

Statistics of Water Use and Treatment

The water supply for human consumption and sewage treatment are, by legislation, of the states' responsibility, and some municipalities, in Brazil. Public and private companies furnish water for the population and industries in the urban areas and collect part of the sewage produced, which is partially treated. Usually, the same institution performs both activities (water supply and sewage treatment). The geographical areas over which these companies act are determined by authorization of state or municipal authorities. Presently, there are some conflicts between states and municipalities about the legal distribution of water supply and waste water treatment.

The non-collected and the collected but non-treated sewage are disposed in soils and water bodies, producing pollution. The sewage is the major cause of water pollution in Brazil.

The statistics about water supply and sewage collection and treatment are dispersed by the companies that have the permission of these services.

IBGE collects a survey (PNSB - National Survey of Sanitary Conditions) concerning information about water supply for human consumption and waste water collection and treatment. The water companies and authorities are requested (questionnaires are sent to be filled and returned) to provide information about the volumes produced and the population attended. Unfortunately, this survey is sporadic, lacking periodicity (PNSB was applied in 2 years: 1989 and 2000). A new edition of PNSB is being projected for the next year (2006). In the PNSB survey, the authorities and companies are requested to inform the number of residences with water supply, sewage collection, and the volume of sewage treated. Questions about the type of sewage treatment are also part of the survey.

Other two surveys of IBGE obtain data about number of residences served by water distribution and sewage collection, without information about the treatments given to the water distributed or to the sewage collected. These are the demographic decennial censuses and the PNAD (National Household Survey), which is applied in the years without census enumeration (nine in ten years). In both cases (census and PNAD) the population served by water supply and waste water collection is inferred from the number of residences with these services. No information about the treatment dispensed to the water distributed or to the sewage collected are obtained in the census or the PNAD.

Irrigation

Irrigation is more frequently used in Brazil in two situations: in the semi arid part of the country and in the areas where more developed and modern agricultural methods are applied. The irrigated cultures are usually driven to exportation, especially when cultivated in the flat areas of Central Brazil, where a marked dry season (3 to 5 months a year) occurs.

The irrigation in the semi arid area is concentrated in the São Francisco valley, a large perennial river that crosses this region. The irrigation is regulated by CODEVASF (São Francisco Valley Development Company) that registers and controls the amount of water used and the area irrigated in the large irrigated projects. The irrigation made by small farmers, for subsistence purposes, is not controlled or computed. São Francisco river waters are equally used to produce hydropower energy, and this creates some conflicts with the irrigation activity. In others parts of the country, this conflict is incipient, although crescent.

In the rest of the country, there are few and fragmented data about use of water for irrigation. ANA (National Water Agency) is now organizing the hydrographic basins committees to discipline the use of water, collect statistics about these uses and about water quality, improve the treatment of sewage, and to solve the conflicts.

Bathing Water Quality

The quality of coastal sea waters is monitored in some beaches of Brazilian coast. This is done by the states (usually by the states environmental agencies) and some municipalities, including by both of them in some of the beaches. Commonly the density of fecal coliforms in water is the parameter used to classify the water quality in Brazilian beaches, but the sampling (frequency and spatial density) and analytical methods vary between different institutions. In a few of the beaches, microbiological analyses of sand are made too. Due to the lack of an efficient treatment of waste waters, the urban beaches have, in general, poor water quality.

Concluding Remarks

Brazil has abundant water resources, but they are unevenly distributed throughout its territory, with areas with natural scarcity (semi arid region) or where the scarcity is due to over exploitation or misuse (pollution) of water resources.

In rather all the aspects, statistics concerning water exist in Brazil, but they are dispersed and poorly organized. The areas where the lack of information is worse encompass underground waters (occurrence, volume, chemical quality, contamination by pollutants and misuse of soil and surface waters, sustainable exploiting volume, etc.) and irrigation (irrigated area, volume of water used, etc.). For these subjects only partial information is available, and overlapping (among institutions), poor organization of data and lack of data during some periods are the major difficulties faced.

The differences in the sampling methods and techniques (periodicity, density of points, way of water collection) and analytical (physical and chemical parameters analyzed and methods) methodologies, and the lack of data during some periods are the most general sources of problems in matters concerning the Brazilian water statistics.

In this context, ANA and IBGE, acting independently, are trying to organize the Brazilian water statistics. The purpose of ANA is to monitor and control the abundance, quality and water uses in Brazil. ANA has a focus on action and control. In the case of IBGE the objectives are to analyze and discuss the use of water in Brazil, the ultimate end of served waters and the consequences of water use in the quality of surface and underground waters. We could say that ANA and IBGE have complementary roles. Another important aspect to IBGE is to provide water statistics, in an easy way, to other institutions, and for the users in general (including students and researchers). IBGE is linked to the Ministry of Planning, and can be described as a public governmental information agency.

At that moment, the projects of organizing Brazilian water statistics, both in ANA and IBGE, are in the first stages, and need support (proceedings, personals and resources) and suggestions.

Another important agent in the water resources management in Brazil is the Ministry of Environment, that is now coordinating the elaboration of Brazilian National Water Resources Plan (Plano Nacional de Recursos Hídricos - PNRH). This plan intends to establish the broad ways of water use in Brazil. Not only the government authorities (federal, state and municipal) are elaborating the PNRH, the users (farmers, industries, etc.) and the society as a whole, participate in this process.

Last but not least, there are important matters that we are facing in Brazil:
- for the same kind of data we have different methodologies in use. How to put together, compare and synthesize these data?;
- there are gaps in the data, creating difficulties to analyze time series;
- the data are dispersed in various institutions, that are linked to different levels of the governmental structure;
- Brazil is a very large country with strong variations of environmental (natural and man made created) conditions. How to summarize the data for the whole country and to choose the data we will disseminate, including to international organizations? For example, about

the quality of river water, we have very polluted rivers, slightly and untouched ones. What river we must choose to represent Brazilian river water quality? In a country with less varied conditions, this choice could be more easily made, but this is not our case. How to synthesize Brazilian water statistics?

Summary Table

Subject	Type of Statistics	Agencies / Institutions	Parameters Measured	Used for / Objectives	Problems Faced
River Waters	Volume of Water	Federal Institutions State Environmental Agencies or State Water Agencies	Volume	Project dams and other constructions, control of floods, etc.	Differences in the Methodologies Used Gaps in time series Overlapping among institutions Incomplete coverage
	Sediments Transported	Federal Institutions State Environmental Agencies or State Water Agencies	Mass of sediments transported	Project dams and other constructions, to calculate the life time of dams, etc.	Differences in the Methodologies Used Gaps in time series Overlapping among institutions Incomplete coverage
Surface Water Quality (rivers, lakes and reservoirs)	Physical and Chemical Analysis of Waters	Environmental Agencies or State Water Agencies	Turbidity, pH, concentration of N, P, other nutrients, heavy metals, organic pollutants, BOD, COD, etc.	Monitor the quality of surface waters Control the actions of industries and others pollutants agents Classification of water for different uses	Differences in sampling and analytical methodologies used Different parameters analyzed Incomplete coverage Dispersion of data
Underground Water	Volume of Water	Federal Institutions (CPRM)	Volume of water stored	Evaluate the underground water reservoirs Evaluate the life time of wells Discipline the use of underground waters	Scarcity of Data. Only a small part of Brazilian aquifers were studied Disorganized use of underground waters
	Water Quality	Federal Institutions (CPRM, IBGE)	Type and Concentration of Salts Concentration of Pollutants	Evaluate the potential uses of underground waters Evaluate the contamination of underground waters	Only a small part of the aquifers yet evaluated have chemical analysis of water

Water Supply	Volume of water distributed Water Quality	State and Municipal Institutions (Public and Private Water Companies) IBGE	Volume Microbiological analysis, turbidity, pH, concentration of N, P, other nutrients, heavy metals, organic pollutants, BOD, COD, etc.	Evaluate the quantity and quality of waters distributed to the population	Spreading and poor organization of data Differences in analytical methodologies Incomplete covering of chemical analysis
Sewage Treatment	Volume collected Volume treated Microbiological, Physical and Chemical Analysis of Waters	State and Municipal Institutions (Public and Private Water Companies) IBGE	Volume Fecal coliforms, Turbidity, pH, concentration of N, P, other nutrients, heavy metals, organic pollutants, BOD, COD, etc.	Evaluate the collection and treatment covering of sewage in Brazil Evaluate the potential pollution caused by waste waters Evaluate the quality of served waters released in the environment	Spreading and poor organization of data Incomplete coverage of chemical analysis
Irrigation	Volume Used Water Quality	Federal Institutions (CODEVASF and ANA)	Volume Salt concentration in waters	Control the quality of waters used for irrigation Avoid soil salinization	Spreading and poor organization of data Only part of the irrigated areas are monitored Partial coverage of chemical data
Bathing Water Quality	Microbiological Water Quality	State and Municipal Institutions (Environmental Agencies and Departments of Environment)	Microbiological analysis of coastal waters and, in some cases, of beach sand	Classify the beaches for recreation purposes Evaluate the coastal waters pollution	Spreading of data Differences in sampling and analytical methodologies used Incomplete coverage Gaps in time series